Contract #12-05I
(Task 4.e)

Little River Water Quality Improvement
Valleyside Farm Fields Nutrient Reduction Project
Task 4.e – Final 319 Report

October 11, 2017

This project is funded in part by the CT DEEP
Through a US EPA Nonpoint Source grant under Section 319 of the Clean Water Act
Executive Summary/Abstract

In November 2016, the Eastern Connecticut Conservation District (ECCD) was awarded funding by the CT Department of Energy and Environmental Protection (CT DEEP) through the Clean Water Act §319 Nonpoint Source grant program to construct a denitrifying woodchip bioreactor in Woodstock, CT and purchase precision planting equipment (PPE) to be used on 650 acres on various fields in Woodstock.

The Eastern Connecticut Conservation District (ECCD) constructed the woodchip bioreactor project with the goal of reducing contaminated tile drain outflow from Valleyside Farm in Woodstock, CT from discharging into a wetland that drains into Mill Brook, thereby improving the water quality of Mill Brook and consequently Roseland Lake and the Little River. Little River provides drinking water to the Town of Putnam and is designated by NRCS as a high-priority watershed under its National Water Quality Initiative (NWQI), a program targeted to assist agricultural producers “to apply conservation measures to address water quality concerns such as excess nitrogen, phosphorous, sediment, and pathogens” (NRCS Press Release, 2/26/16).

Valleyside Farm was identified as needing a system to treat subsurface tile drain outflow prior to its discharging into Mill Brook, using an environmentally sound method, reflecting the USDA/NRCS CPS Code 747 for a Denitrifying Bioreactor, to prevent discharge of NPS to the impaired Little River. To further reduce nutrients from discharging from Valleyside’s farm fields, ECCD in collaboration with Valleyside Farm, sourced and purchased precision planting equipment which will allow Valleyside to plant its corn into a living cover crop. By planting corn into a living cover crop, the PPE will allow the cover crop to remain on the fields longer, continuing to fix nitrogen while reducing run-off and the discharge of sediment and nutrients into receiving waters.

Upon receiving the executed contract in November 2016, ECCD partnered with CT DEEP, the Natural Resources Conservation Service, Farm Service Agency and Valleyside Farm to implement the BMPs.

The project was conducted by ECCD and Valleyside Farm, Inc. The §319 funds covered a percentage of the costs, but not all. The remainder of the project costs was covered primarily by Valleyside Farm’s professional labor, equipment, materials and funds, but also by ECCD’s match of in-kind services. NRCS also provided valuable services, the wetland delineation and locating of the tile drain using ground-penetrating radar, which are not documented as match. The Farm Service Agency sought permission from Valleyside to release information, then provided field and tract data, as well as maps.

Introduction

The Eastern Connecticut Conservation District is a non-profit organization which, among other activities, conducts water quality improvement projects that address non-point source pollution problems. Many of ECCD’s projects involve working with local farmers to reduce the amount of contaminated runoff originating from their farming operations.

The focus of ECCD’s efforts for this project was water quality improvement of Mill Brook, Roseland Lake and the Little River. One of the overriding features of this watershed is the density of agricultural operations, and thus these operations are suspected to be a primary source of NPS. Valleyside Farm was chosen because it is situated within the Little River Watershed. This
watershed provides source drinking water to Putnam and has been targeted for restoration by CT DEEP and NRCS through its NWQI.

In November 2016, the Eastern Connecticut Conservation District (ECCD) was awarded funding by the CT Department of Energy and Environmental Protection (CT DEEP) through the Clean Water Act §319 Nonpoint Source grant program to construct an anaerobic woodchip bioreactor in Woodstock, CT and purchase precision plant equipment to be used on 650 acres on various fields in Woodstock.

Planning for the woodchip bioreactor, preparations, permitting, BMP designs, material purchases and construction of the facility were completed on August 14, 2017. Purchase and installation of the precision planting equipment was completed on February 13, 2017. A planting plan and schedule was submitted to CT DEEP and a trial run of the equipment was conducted on April 28, 2017. The PPE was used during the last week of April and the first week of May, 2017.

The Resource, Environmental Problems

Little River provides drinking water to the Town of Putnam and is designated by NRCS as a high priority watershed under its National Water Quality Initiative (NWQI), a program targeted to assist agricultural producers “to apply conservation measures to address water quality concerns such as excess nitrogen, phosphorous, sediment, and pathogens” (NRCS Press Release, 2/26/16). The 2012 State of Connecticut Integrated Water Quality Report identified causes and sources of nonpoint source impairment(s) in the Little River watershed including:

1. Muddy Brook (Woodstock)- 01 CT3708-01_01: Cause, *Escherichia coli*: Potential Sources include permitted and non-permitted stormwater, insufficient septic systems, agricultural activity and nuisance wildlife/pets.
2. Peckham Brook (Woodstock)-01 CT3708-08_01, Cause *Escherichia coli*: Potential sources include permitted and non-permitted stormwater, insufficient septic systems, agricultural activity, nuisance wildlife/pets.
3. Roseland Lake (Woodstock) CT3708-00-1-L1_01 Cause, Nutrient/ Eutrophication Biological Indicators: Potential sources include Out-of-State sources, municipal discharges, stormwater.

Valleyside Farm plants corn throughout the Little River Watershed, so all three sub-watersheds listed above are impacted by agricultural run-off, which carries nutrients and pathogens, from the fields.

Valleyside Farm also grows hay for forage. One of its hayfields is tile-drained and discharges from the tile-drain outlet directly into an adjacent wetland which drains into Mill Brook, then discharges into Roseland Lake and Little River, transporting nutrients and pathogens into receiving waterbodies.

The Solution

Since Valleyside plants corn throughout the Little River Watershed, all of the sub-watersheds listed above will be affected by the use of the precision planting equipment. Previous to this project, Valleyside had planted its cover crop at the end of the growing season and terminated it in
early spring, prior to planting its corn. The precision planting equipment will allow Valleyside to plant its corn directly into a living cover crop. Therefore, the cover crop will remain on the fields for a longer period of time, providing soil health benefits while preventing, for a longer period of time, the discharge of sediment, nutrients and pathogens into the Little River Watershed.

A tile-drained field at Valleyside Farm discharged its outflow directly into a wetland that flows into Mill Brook, and subsequently into Roseland Lake, Little River and Long Island Sound. The solution involved constructing a denitrifying woodchip bioreactor, reflecting USDA/NRCS CPS Code 747 for a Denitrifying Bioreactor, to treat the run-off and reduce the discharge of NPS to Roseland Lake and Little River.

To address this problem, an anaerobic woodchip bioreactor was constructed. The bioreactor was sized to accommodate the size of the field which the tile drains served. It was determined that a 12’X100’ bioreactor would be required. The bioreactor was designed by Reynolds Engineering and constructed by Valleyside Farm, Inc. The bioreactor consisted of inflow and outflow control structures to calibrate the flow into the system and to facilitate the sampling of water prior to entering and upon discharge from the bioreactor.

An anaerobic woodchip bioreactor is an NRCS practice used more widely in the mid-western U.S., preventing outflow from a tile-drained field from discharging nutrients into receiving waterbodies. A denitrifying bioreactor is typically a ditch filled with woodchips, then covered with soil. Intercepting the outflow from the tile drain system, the untreated, nutrient-enriched tile drain runoff is directed to flow through the woodchips. Using natural denitrifying soil bacteria, the nitrate concentration in the runoff is reduced, transformed into Nitrous oxide or N₂ gas.

Project Partners and Funding

Project partners included the Eastern Connecticut Conservation District, Valleyside Farm, Inc., the Connecticut Department of Energy and Environmental Protection, the Natural Resources Conservation Service, the U.S. Environmental Protection Agency and the Farm Service Agency. This project was funded in part by the CT DEEP through the US EPA Clean Water Act §319 Non-point Source grant program in the amount of $95,000. Contributory match provided by ECCD and project partners was approximately $63,401 for a total investment of over $158,401. Project partners and their roles in the Little River Water Quality Improvement Project – Valleyside Farm Fields Nutrient Reduction Project are listed in the table below.

Valleyside Farm Fields Nutrient Reduction Project Partners

<table>
<thead>
<tr>
<th>Partner</th>
<th>Role/Responsibilities</th>
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<tbody>
<tr>
<td>ECCD</td>
<td>Project management, planning/coordination, material sourcing and acquisition, installation supervision and inspection, education &amp; outreach</td>
</tr>
<tr>
<td>CT DEEP - Watershed Management Division</td>
<td>Project oversight, financial and technical assistance</td>
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<tr>
<td>NRCS</td>
<td>Location and mapping of tile drain system with ground-penetrating radar; delineation and flagging of wetland; provision of original tile drain design drawings</td>
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Farm Service Agency | Sought permission from Valleyside and provided maps of its farm fields. Also, provided Form AD 1026, *Highly Erodible Land Conservation & Wetland Conservation Certification*.

Valleyside Farm, Inc. | Project oversight, installing PPE onto corn planter, contributing funds to purchase of PPE, BMP site selection, bioreactor installation, material sourcing and acquisition, BMP ownership/maintenance, education & outreach

Mark Reynolds Engineering | Designed woodchip bioreactor; site survey

Jolley Precast Concrete, Inc. | Manufacture of four manholes

Hull Forest Products | Donation of 150 yards of hardwood woodchips

Results

ECCD, Valleyside Farm and project partners successfully installed the denitrifying bioreactor. ECCD managed the project. Valleyside Farm proprietor, Lucas Young, provided project oversight and installed the bioreactor. Lucas Young also installed the precision planting equipment onto the farm’s corn planter.

Denitrifying Woodchip Bioreactor

Inland Wetlands and Watercourses Approval

On January 9, 2017, two ECCD staff presented the project to Woodstock’s Inland Wetlands and Watercourses Agency for approval. Since the site was located adjacent to a wetland in the upland review area, ECCD staff attended the January meeting to seek a ruling and approval to construct the bioreactor. The IWWA approved the project as a “use permitted as of right” (Request for Determination dated 1/17/17).

Construction Process

Preconstruction Meeting

ECCD staff coordinated with project partners to schedule and conduct a pre-construction meeting, which was held on June 29, 2017. Present at the meeting were Lucas Young (Valleyside Farm and contractor to install bioreactor), Mark Reynolds (project engineer) and Dan Mullins (ECCD project manager). ECCD staff was on site throughout the construction process, ensuring that the engineered design was followed and that the construction schedule was followed as described in the engineered plan.

Sourcing and Acquisition of Materials

ECCD staff and Valleyside Farm staff collaborated to source materials for the project. Valleyside sourced and acquired the bioreactor liner. ECCD sourced and acquired the geotextile fabric to
cover the woodchips, the silt fence, the pvc pipe, the manholes and the woodchips, which were donated by Hull Forest Products and picked up by Valleyside Farm staff. Valleyside also provided the seed to re-plant the construction site, as well as the hay to armor the site against erosion post-construction.

**Sourcing and Ordering Manholes from Jolley Precast**

On July 6, 2017, ECCD staff met with Dennis Jolley of Jolley Precast to properly size and design the four manholes needed for the bioreactor drainage and flow-control system. ECCD placed the order for the manholes on July 25, 2017 and they were delivered on August 2, 2017. Upon receipt of the manholes, Lucas Young quickly observed that one of the boots for the outlet control structure had been misplaced. ECCD contacted Jolley Concrete. Dennis Jolley concurred and determined that there was a glitch in software used to design the manholes causing a numerical miscalculation. Jolley retrieved the manhole immediately, corrected the mis-placed boot and delivered the manhole the next day, turning it around in less than 24 hours demonstrating remarkable customer service.

**Constructing the Weir for the Outflow Control Structure**

Upon receipt of the manholes, Valleyside Farm staff constructed the weir for the outlet control structure, adapting the manhole to control water levels in the bioreactor.

**Laying Out the Site According to the Design**

The day before construction began, Valleyside staff layed out the bioreactor site, staking out the bioreactor parameters according to the engineered plan and installing erosion control measures.

**Construction of the Bioreactor**

The woodchip bioreactor was constructed between August 7 and August 10, 2017, and final grading was completed on August 11th, when post-construction site stabilization was implemented. Hay was spread over exposed soil to prevent erosion and the site was seeded with grass.

Whereas the construction of the bioreactor went as planned (Task 2.e Bioreactor Installation report submitted to CT DEEP on August, 15, 2017), and the bioreactor was installed and is operating as designed, receipt of the engineered plans was delayed by the engineer who did not prioritize the project. The engineered designs were submitted to ECCD more than four months beyond the contractual deadline of March 1, 2017.

**Precision Planting Equipment**

ECCD and Valleyside collaborated to research and source the precision planting equipment. Due to the company’s experience with the equipment and its ability to provide technical assistance, we selected Salem Farm Supply, Inc (Salem, NY) from which to purchase the PPE. The component parts of the PPE was received by Valleyside Farm on January 18, 2017 and Lucas Young installed the PPE onto the farm’s corn planter between January 18 and February 13, 2017. Field trials of the new equipment was conducted on April 28, 2017. Lucas Young was visibly excited and enthusiastic when discussing the PPE during the field trial.
Valleyside Farm began using the PPE this spring, seeding its corn fields during the last week of April and the first week of May. The cover crop which would have normally been terminated 2-3 weeks sooner remained in the fields until 2-3 days after the corn had begun to sprout.

**Water Quality Monitoring**

Under Task 2.c of the contract to implement the bioreactor BMP, ECCD was charged with conducting water quality monitoring at the inflow and outflow structures. Unfortunately, the bioreactor phase construction timeline was delayed due to having received the final bioreactor designs from Reynolds Engineering more than four months beyond the contractual deadline of March 1, 2017. As a result of this delay, the water quality monitoring task and associated outreach was not completed. However, the bioreactor has been installed and is currently operating. The water quality monitoring will be incorporated into a focused new grant agreement with DEEP in the near future. ECCD looks forward to receiving the contract and monitoring the effectiveness of the bioreactor to treat the tile drain outflow.

**Future Plans**

ECCD will continue to promote the project into the future to the general public and local farmers. The proximity of Valleyside Farm to other farms in northeast CT provides an excellent opportunity for future educational activities, including guided tours. ECCD will continue to monitor the project and work with Valleyside Farm staff to ensure the BMP is properly maintained and remains in good working condition.

Valleyside Farm proprietor, Lucas Young, has begun to use the precision planting equipment, sowing approximately 830 acres of corn into a living cover crop. Consequently, the cover crop remained on the fields for an additional 2-3 weeks, increasing the value of the cover crop to scavenge and fix nitrogen and prevent nutrient loss, as well as reduce nonpoint source pollution, sediment discharge and erosion.

ECCD will pursue future funding to conduct additional water quality improvement projects at Valleyside Farm and other agricultural producers in the Little River watershed.

**Conclusions**

**Success of the Project**

The denitrifying bioreactor was installed successfully and on time, demonstrating the commitment of Valleyside Farm to addressing agricultural NPS. The owner of the farm provided significant amounts of personal time, funding, professional staff labor, equipment, tools and materials to the construction of the facility. The direct involvement of the farm staff in the construction of the facility engenders in them a sense of accomplishment and pride. More importantly, however, their involvement provides them with first-hand knowledge about the facility’s structural components, as well as its purpose and capacity. Additionally, since Valleyside Farm constructed the BMP, farm staff possess direct knowledge of its structural and functional elements, which will contribute to the desire and ability to operate and maintain it.
Valleyside Farm purchased an upgraded corn planter, then installed the precision planting equipment onto it. Lucas Young possesses unique qualifications that facilitated both the installation of the PPE and its operation. The PPE is highly technological and Lucas Young’s degree in agricultural engineering is an important asset to Valleyside as the farm transitions to the new technology.

**Difficulties and How Resolved**

The site selected for the bioreactor is located at the bottom of an incline, upgradient of a former pasture that contains a wetland. Valleyside preferred to install the bioreactor in the pasture, though it was determined by the engineer that the soils were too wet and were frequently saturated with moisture. Consequently, Valleyside approved siting the bioreactor on the edge of the hay field. Additionally, the engineer expressed concerns about the relatively steep gradient of the hay field and the potential for surface runoff to inundate the system during high rain events. Therefore, the bioreactor was designed with an elevated berm upgradient of the system to redirect surface water around the bioreactor.

A minor, potentially difficult, challenge arose when it was discovered that one of the boots for the outlet control structure had been misplaced in the manhole. However, the remarkable customer service provided by Jolley Concrete to retrieve the manhole immediately, correct the mis-placed boot and deliver the manhole the next day, averted any further delays.

The most profound difficulty resulted from the late delivery of the engineered plans by Reynolds Engineering. As a result, the bioreactor was installed 5 months later than intended. With a CT DEEP contract deadline of September 30th, ECCD was unable to conduct water quality monitoring to assess the removal rates of nitrogen from the water, which would have provided important information about the effectiveness of the system. However, it does seem likely that ECCD will receive a new grant agreement from DEEP to conduct the water quality monitoring.

**Recipient Evaluation of Project Effectiveness**

Valleyside Farm proprieter, Lucas Young:

> The precision planting equipment greatly improved my corn crop this year in the challenging growing conditions. The control of down force really shined where the soil was wet and soft by not over compressing the soil around the seed bed. The clean sweep row cleaners enabled me to plant into living covers which I delayed terminating because of the wetter than normal conditions to help pull more moisture out of the soil. This practice also allowed me to do a single spray pass rather than my traditional two. To top it off all the data from the planter was saved to my iPad for future reference and decision making. As for the bioreactor, I am excited to see what results we get. The install went really well. I think the design will be long lasting and very easy to manage and maintain (Email correspondence, 9/22/17).

The long-term effectiveness of the woodchip bioreactor to remove nitrogen from the tile drain effluent will be determined in the future when funding becomes available to conduct water quality
monitoring. Nonetheless, being professionally engineered by a former NRCS engineer, it is expected that the system will function as designed.

**Recommendations for Continued Action**

ECCD recommends that Valleyside Farm monitor the bioreactor and follow the O&M Plans for both the denitrifying woodchip bioreactor and the precision planting equipment. When funding becomes available through CT DEEP’s EPA CWA Sec. 319 Program to conduct water quality monitoring at the intake and outflow of the bioreactor, ECCD will monitor water quality and provide the results to CT DEEP and Valleyside Farm, which can be used to assess the effectiveness of the bioreactor and to inform its ongoing operation.

**Before and After Implementation Photos**

*Figure 1: Corn Planter in Shop Prior to Installation of Precision Planting Equipment*

*Figure 2: Floating Row Cleaner(L)/Corn Planter During Installation of Precision Planting Equipment(R)
Figure 3: PPE During Field Trial.

Figure 4. Site of bioreactor prior to installation. ECCD staff locating tile-drain pipe.
Figure 5. Google Earth image of bioreactor site prior to installation.

Figure 6. Bioreactor during installation.
Figure 7. Woodchip Bioreactor site after installation

Respectfully submitted,

[Signature]

Daniel Mullins
Executive Director
Eastern Connecticut Conservation District